



A New Direction in Mixed-Signal

# Exar Corporation

July 2013

# Power Product Portfolio

## Product Segments

### POWER CONVERSION

*Switching Controllers  
Switching Regulators  
Linear LDOs and Regulators*

### SYSTEM CONTROLS

*Linear Voltage References  
Supervisors  
Power Switches*



*Step Up/Down Regulators  
SuperCapacitor Charger/Drivers  
High/Low Side Linear Current Drivers*

### LED LIGHTING

*Award winning technology...*

*Field Programmable System Level  
Power Supply Solutions  
Powerful Graphical Dev. Tool  
Power<sup>XR</sup>*

### PROGRAMMABLE POWER

# Focus

## MARKETS

NETWORKING &  
STORAGE

INDUSTRIAL &  
EMBEDDED SYSTEMS

COMMUNICATIONS  
INFRASTRUCTURE

## PRODUCTS

POWER

CONNECTIVITY

HIGH PERFORMANCE  
ANALOG

DATA MANAGEMENT

# Exar Overview

- Top-Tier High Performance Analog Mixed-Signal Integrated Circuits and Sub-Systems Provider
- Markets:
  - Networking and Storage
  - Industrial and Embedded Systems
  - Communications Infrastructure
- Broad Based Product Portfolio
  - Differentiated Solutions that Improve our Customer's Products and Time to Market
  - Plus Second Source offerings: Cross Reference Tools
- Superior Technical Support
  - "Hotline" contacts offering complete product support
- World Class Quality and Delivery Performance – ISO9001 Certified

# Programmable Power Agenda

- Description of Programmable Power
- Designing with the Power<sup>XR</sup> Controllers
  - Using PowerArchitect<sup>TM</sup>
- Applying Software to the Power System

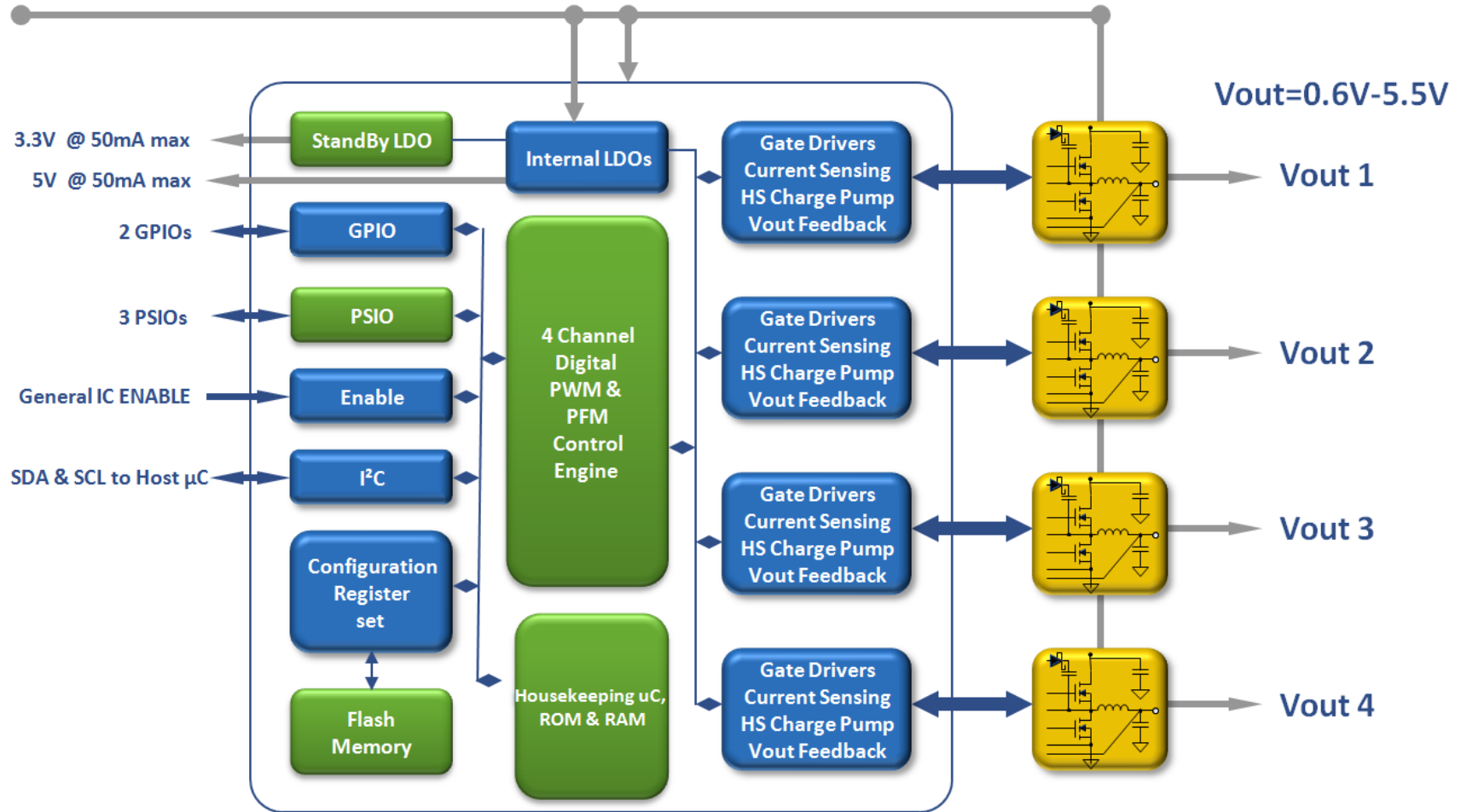
# Benefits of Power<sup>XR</sup> Programmable Power

- Flexible
- Fast Prototyping and TTM
- Fast production changes
- Reduced Components
- Remote field serviceability
- Vastly Improved Power Management functionality
- Improved reliability
- Proprietary applications

# XRP7724 Functional Block Diagram

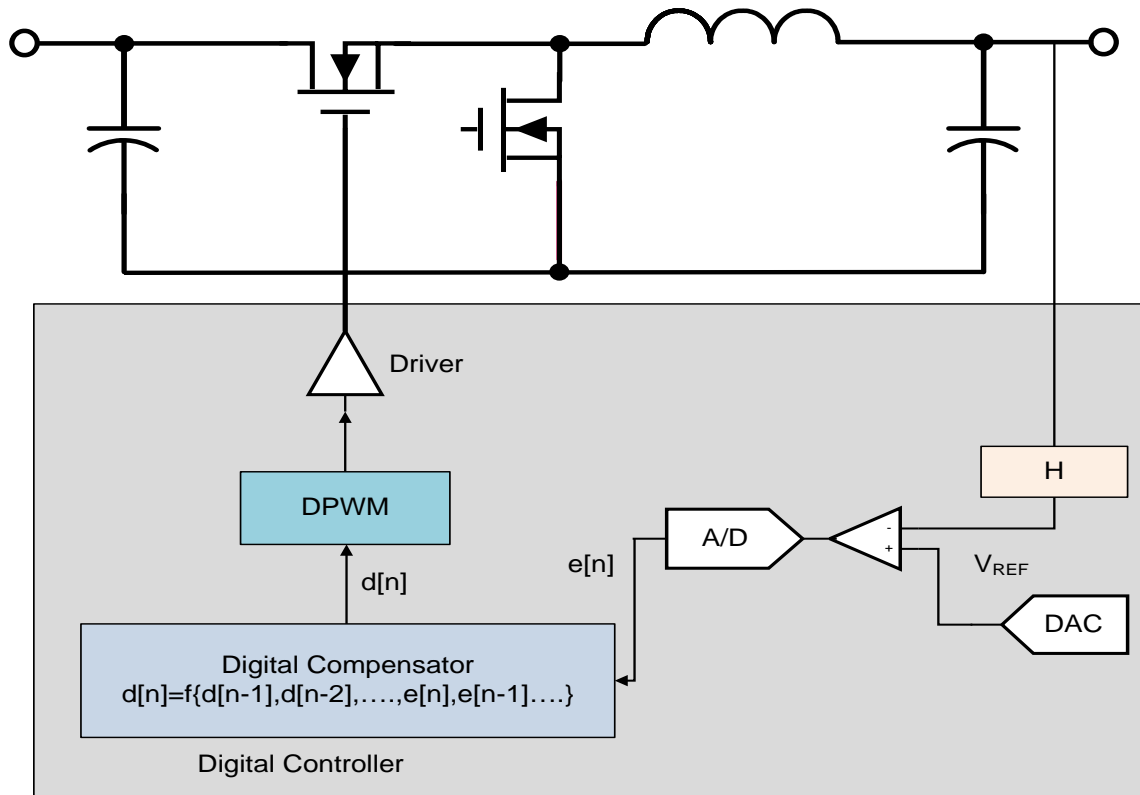
Vin=5.5V-25V

Vin-4.75V-5.5V



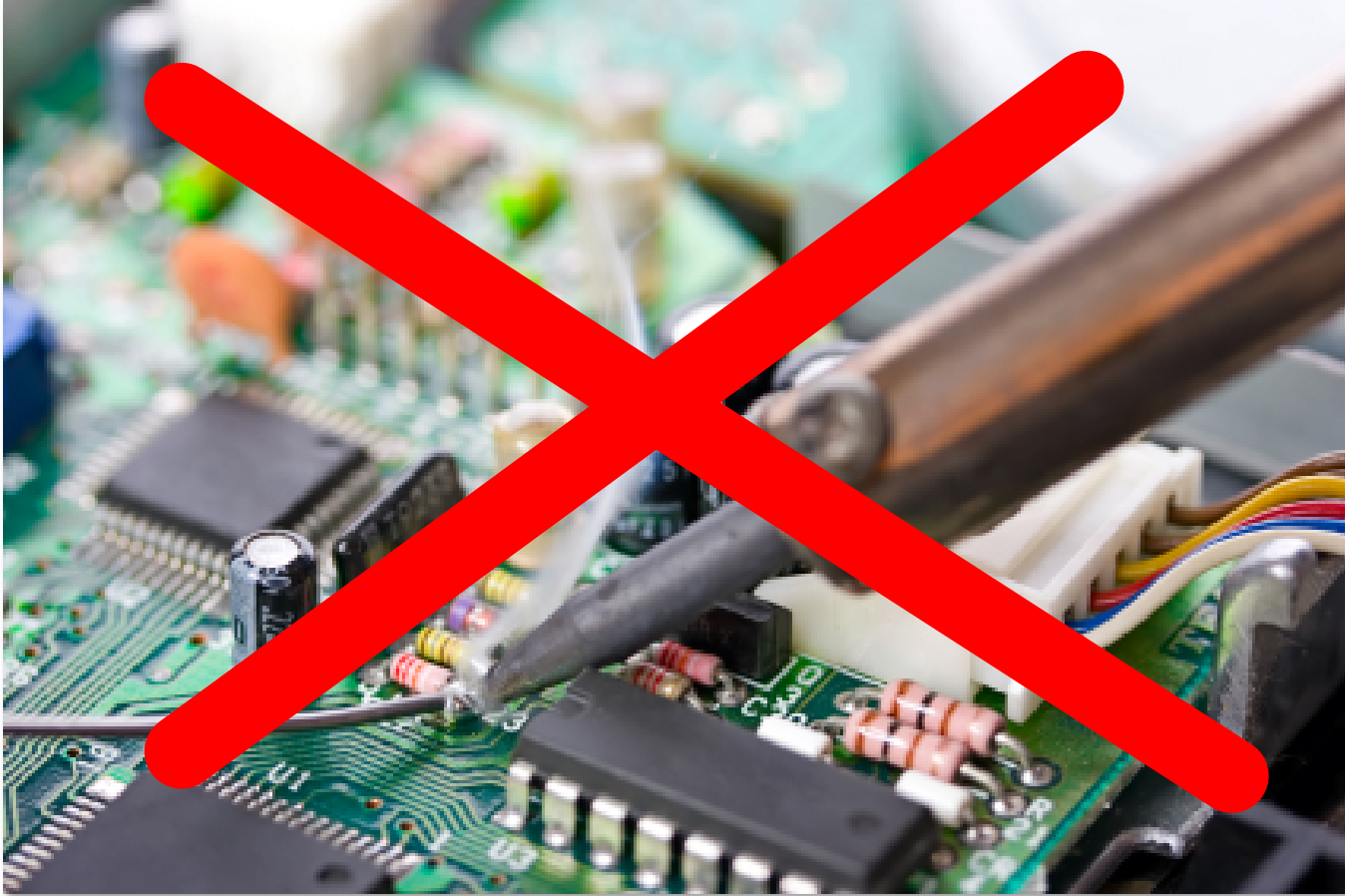
# XRP77xx Control Loop Architecture

- Small geometry (0.18um) BiCMOS mixed-signal process
- 1.8V digital core logic
- No code/firmware used. Hard coded state machine.
- Reliable, self-programmable OTP anti-fuse memory

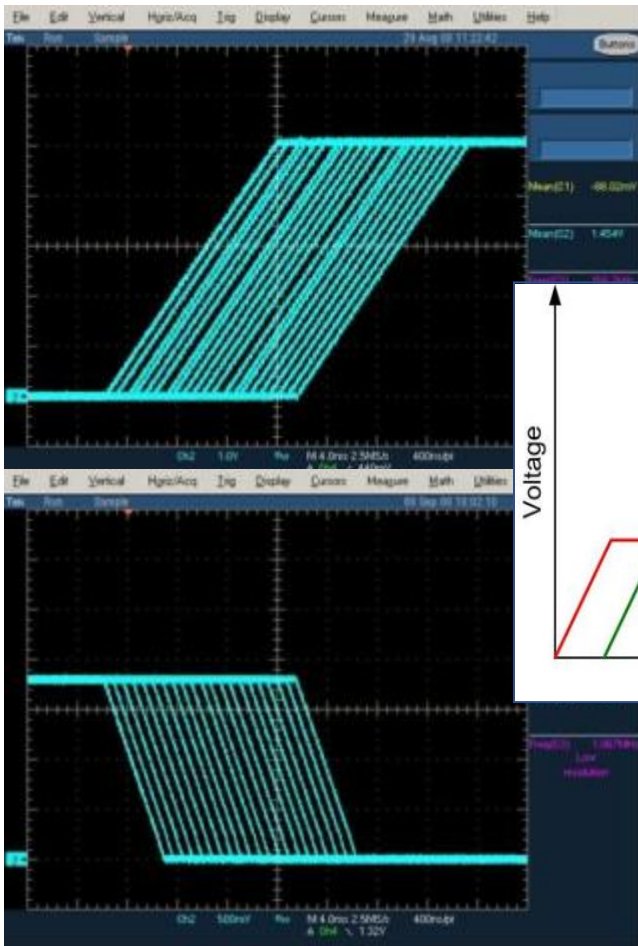




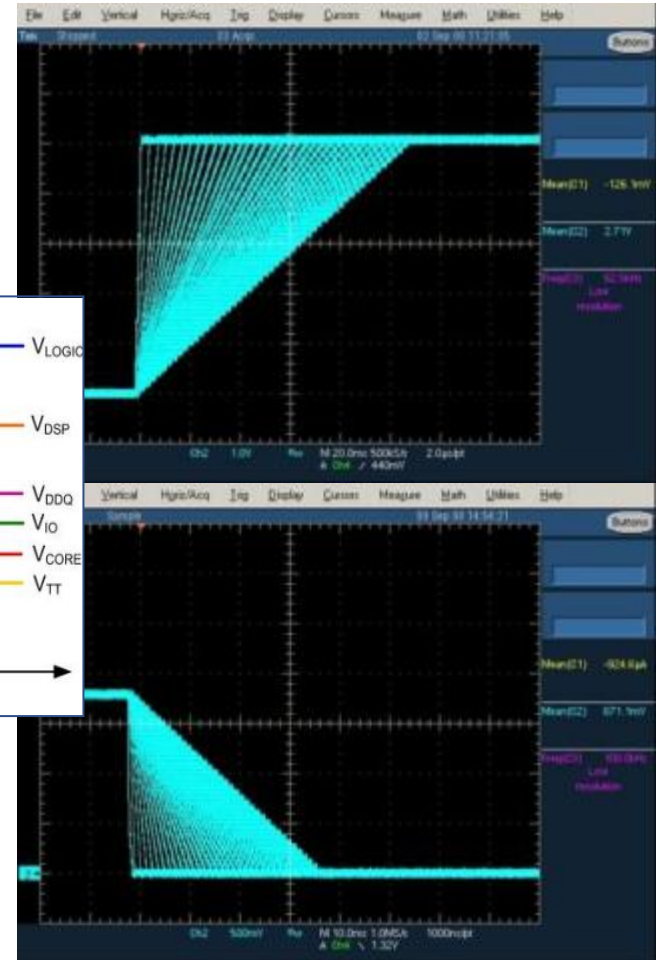
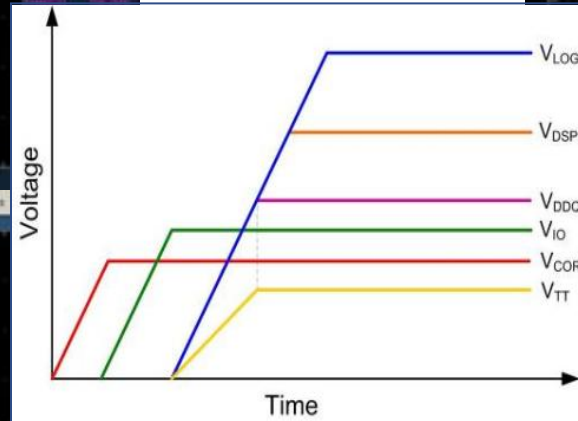
# Sequencing the Old Way



# Sequencing the New Way

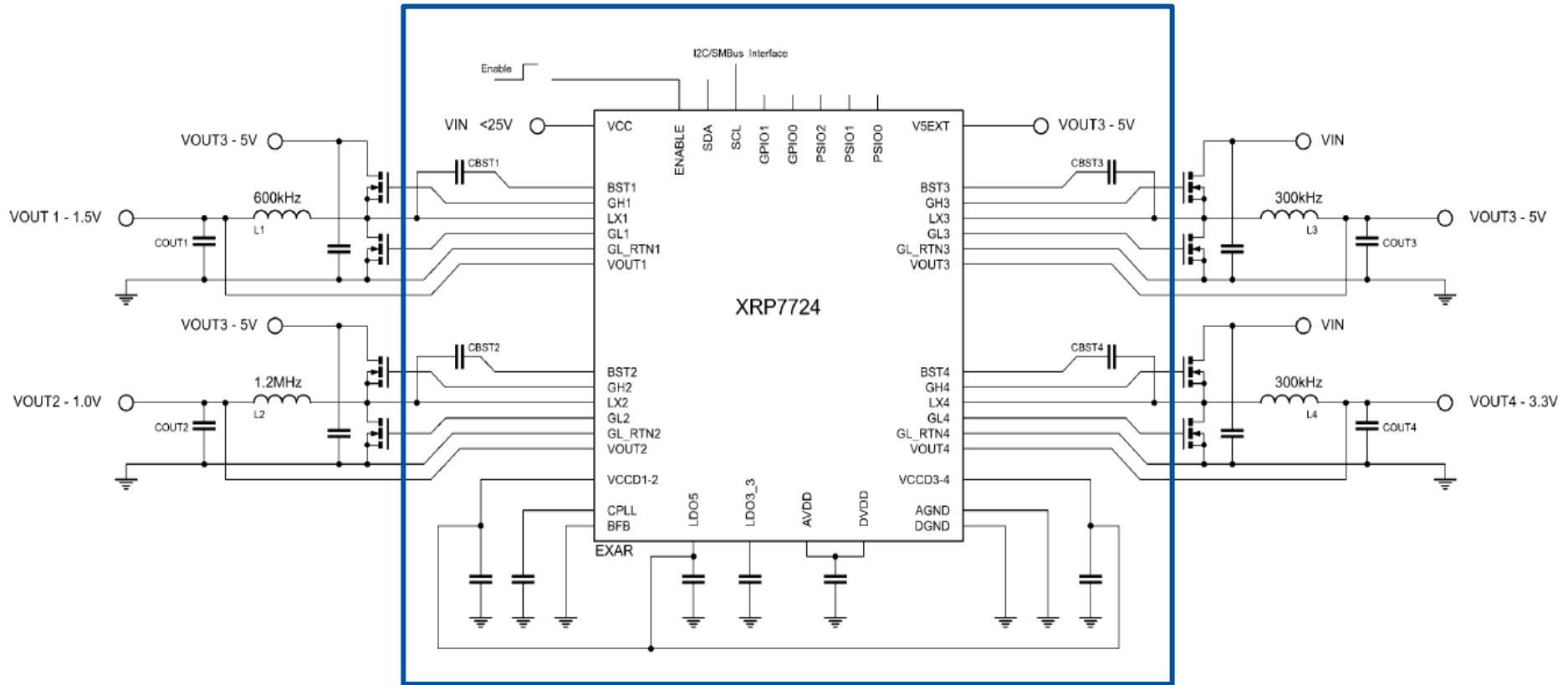


With different delays



With different slopes

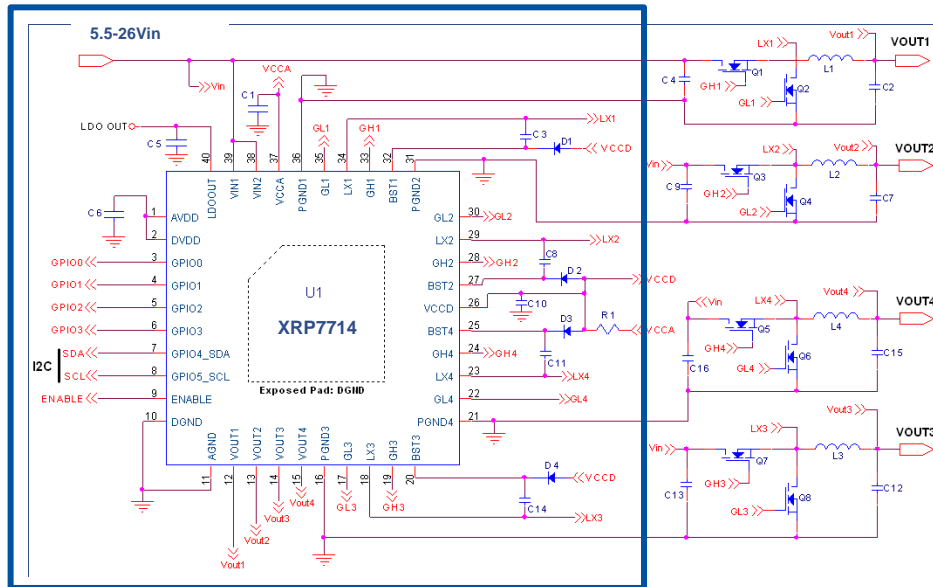
# XRP7724 - Application Schematic



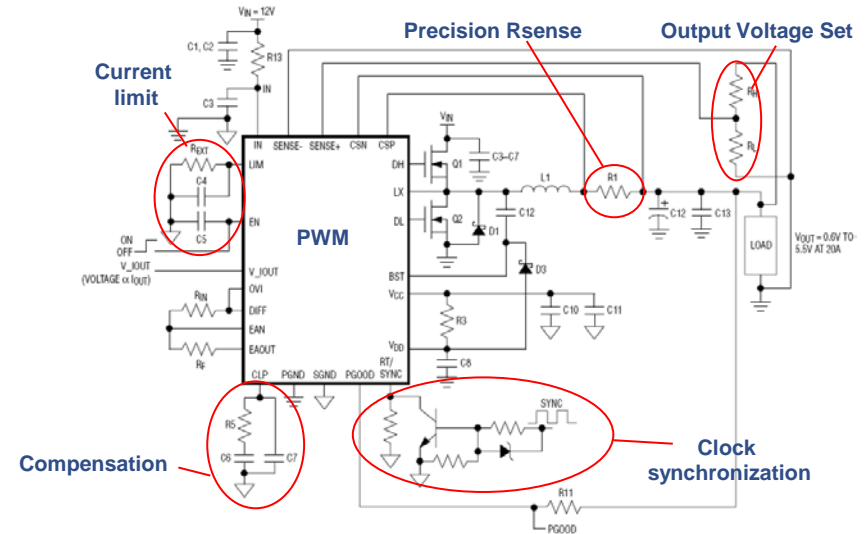
**A Constant Block in all designs yet programmable  
to meet a wide variety of applications**

# Programmable Power is Economical

XRP77xx (33 components for all 4 channels)

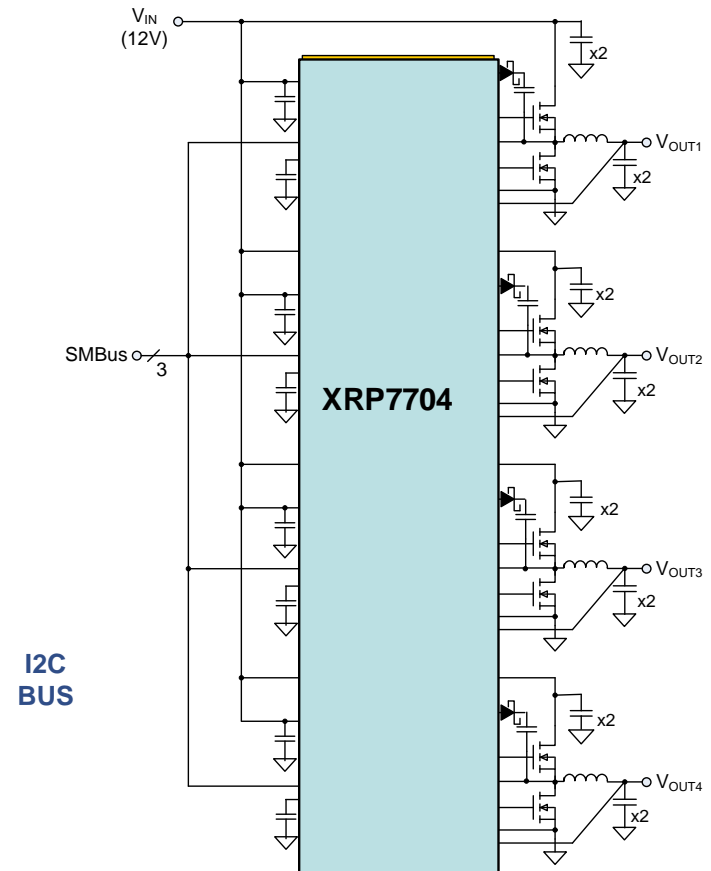
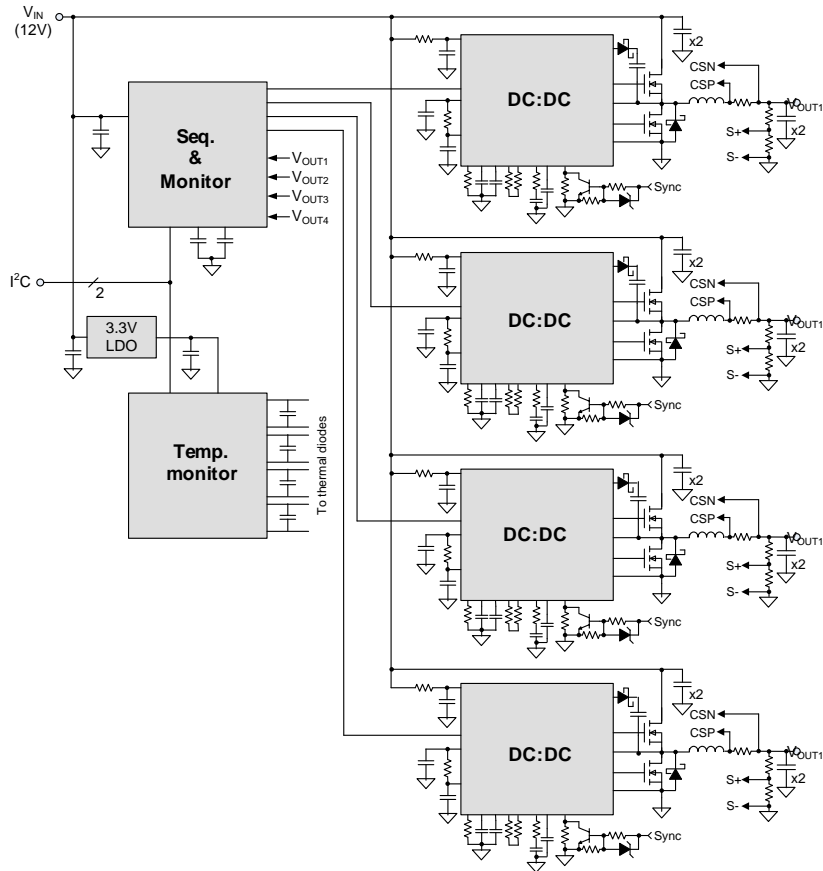


Analog PWM (148 components for 4 channels)



XRP77XX	Features	Analog
33	Components (4 channel)	147
Yes	Soft-start	Discrete
Yes	Margining	Discrete
Yes	Sequencing & Tracking	Discrete
Yes	Dynamic Voltage Control	No
Yes	Conditional Fault Management	No
Yes	I <sup>2</sup> C Bus Interface	No

# Power<sup>XR</sup> Digital and Analog 4 Output Comparison



Analog	Vendor	EXAR
7	Active components	4
148	Discrete components	33
2	Number of supplies required	1

# Exar's Differentiation

- Iq per channel -  $<1.5\text{mA}$  vs industry at  $30\text{mA}$
- State Machine based
  - no firmware updates that will not fit in the space available
- Lower cost than other digital solutions
  - Or analog with added telemetry chips
- Easy to use tools
- Lower Component Count – Analog and Digital
- Intuitive register map
- Only Digital PFM for high light load efficiency

# Programmable Power

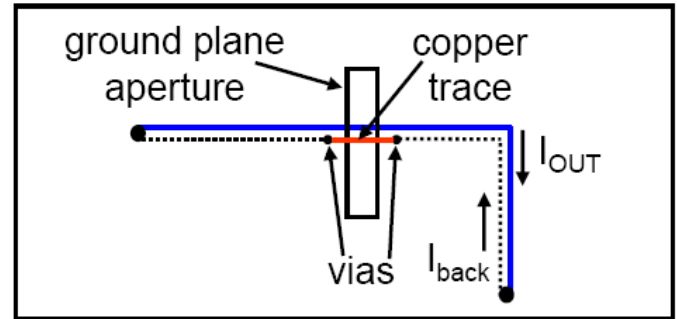
## Programmable Power System Selector

	XRP7704	XRP7708	XRP7740	XRP7713	XRP7714	XRP7724
Channels	4	4	4	3	4	4
Input Voltage	6.5V-20V			4.75V-25V		4.75V-25V
Output Voltage	0.9V-5.1V			0.9V-5.1V		0.6V-5.5V
FET Drive Res.	3Ω/3Ω	5Ω/1.8Ω	3Ω/1.8Ω	6Ω/3Ω		4Ω/2Ω
Vo Resolution	50mV / 100mV			50mV / 100mV		2.5mV/5mV/10mV
Quiescent Current	9mA			9mA		4mA
Control Scheme	DPWM 300kHz-1.5MHz			DPWM 300kHz-1.5MHz		DPFM/DPWM 106kHz-1.2MHz 1x; 2x; 4x Selectable
Phases	Selectable 90°/120°			Fixed 90°		Fixed 90°
Com.	I <sup>2</sup> C			I <sup>2</sup> C		SMBus/I <sup>2</sup> C
GPIOs	4+2			4+2		2+3 PSIO
LDOs	Single 3.3V or 5V – 110mA			Single 3.3V or 5V – 110mA		Dual 3.3V & 5V / 110mA
Memory Type	OTP			OTP		Flash
Package	6x6 TQFN40			5x5 TQFN32	6x6 TQFN40	7x7 TQFN44



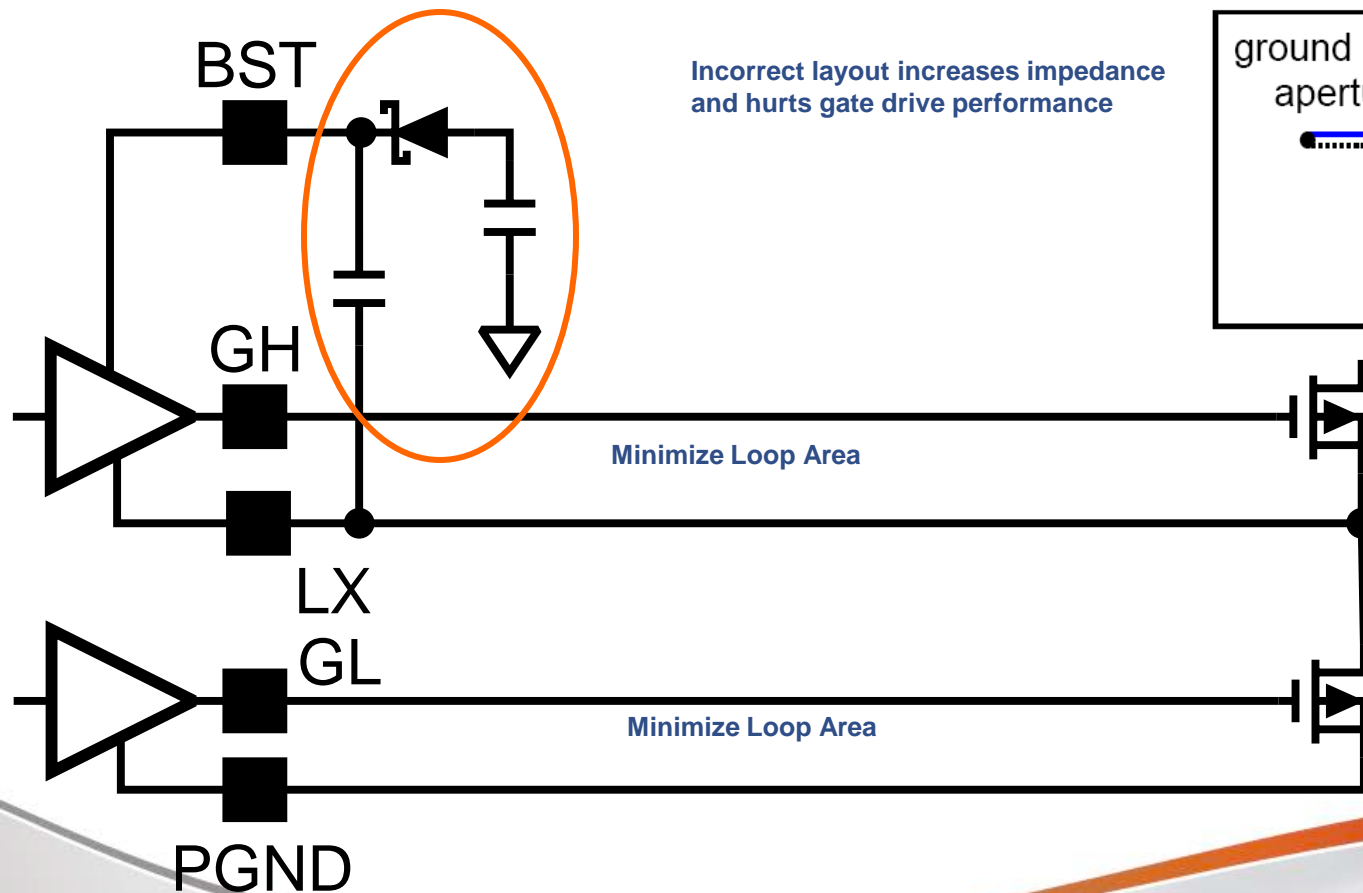
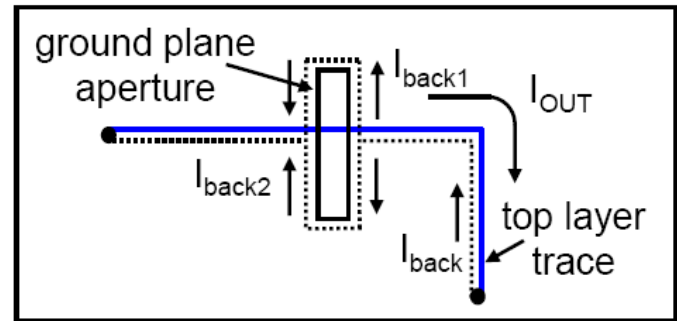
# Layout ANP-32

Proper trace layout to reduce AC impedance



Place near IC, not FETs

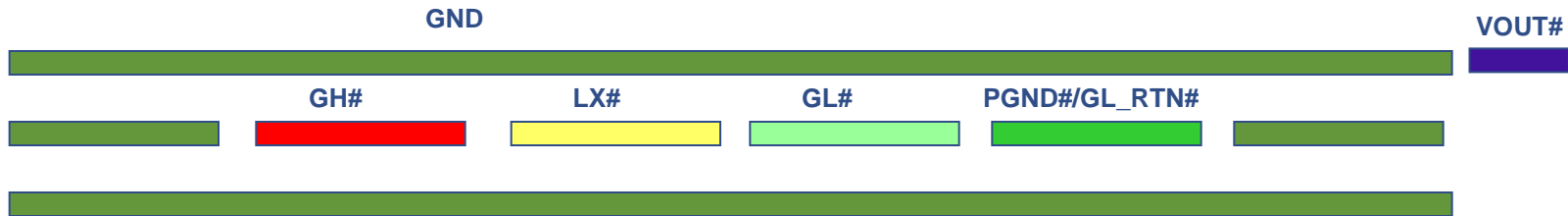
Incorrect layout increases impedance and hurts gate drive performance



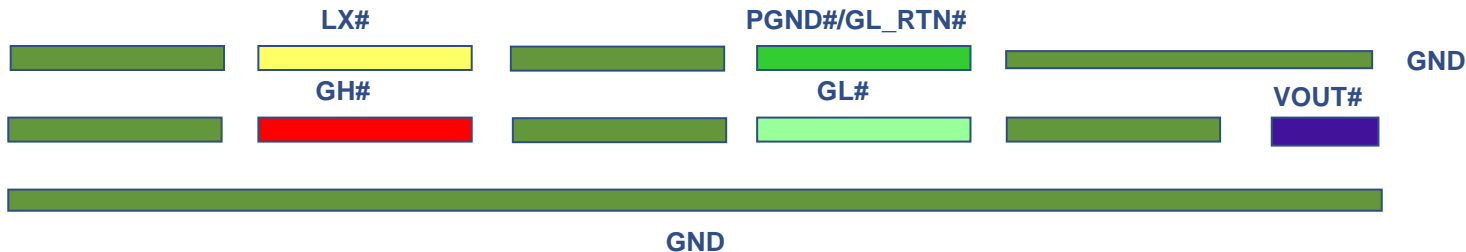


# Long Distance Gate Drive Options

## Cross Section 1 – ANP-32



## Cross Section 2 – ANP-35



- The ground planes reduce noise and act as Faraday shield isolating these noisy traces from the rest of the system
- GH moves from  $V_{in}+5V$  to  $-2V$  in 20ns
- PGND is return path of GL
- Vout is separated from the other traces to avoid any coupling



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# PowerArchitect™ 5.02-r0

## Demo

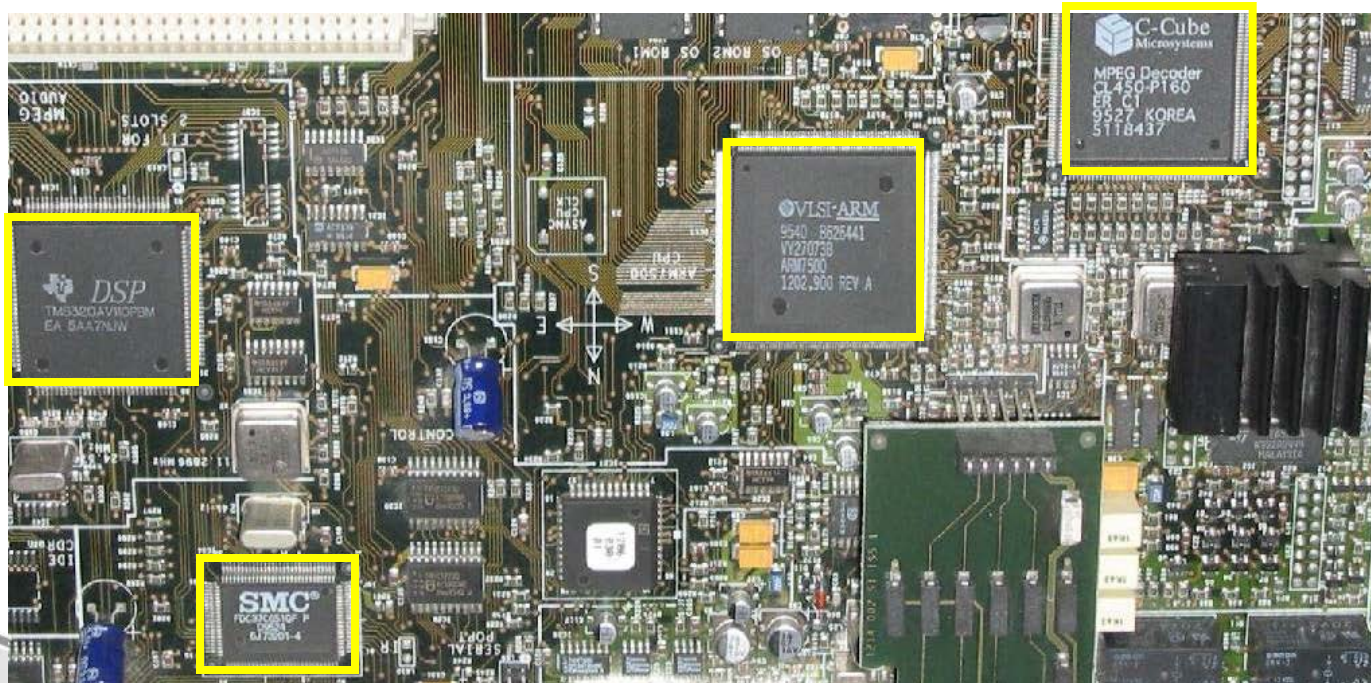


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# Applying Software to the Power System

# Hardware vs Software

- The hardware is the same available to all
- The differentiation is what YOU do with it
  - Firmware and software
- Power<sup>XR</sup> allows YOU to bring additional differentiation through the power system



# Case Study – Applying Programmable Power

- Fast Time To Market
- It takes a crisis to get a software engineers attention
- More features as software engineering understands the capability
- HW and SW team create a fully dynamic power system saving 10% power

# Fault or System Health

- “The Smart Grid can monitor the health of loads, if the load increases from normal, the system can flag a warning” Derek Phillips, Director, Freescale Semiconductor
- The same is true of the power system enabled by Power<sup>XR</sup>
- Algorithms can be developed for predictive failure
- Absolute accuracy not essential



# Energy Monitoring in Server Systems

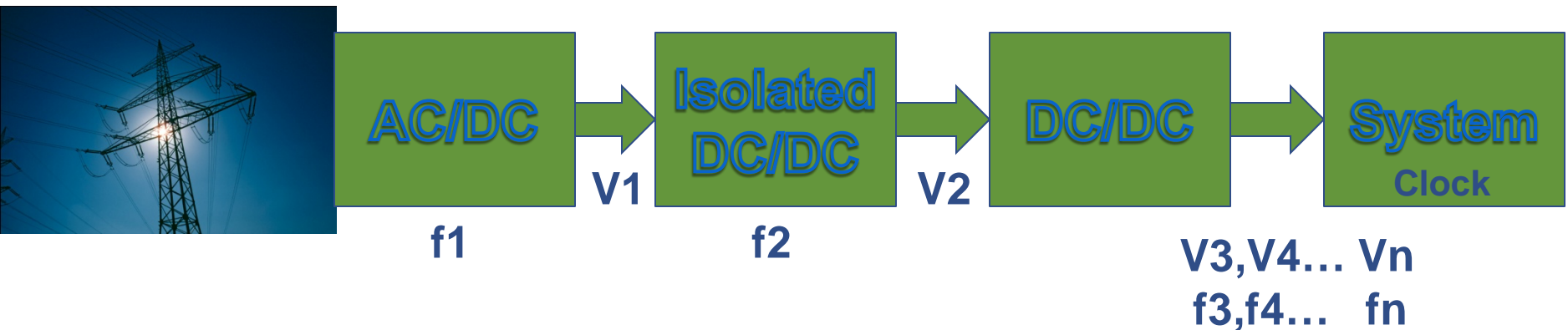
- Real time power monitoring
- Aid in moving measurement from PDU/rack to individual Servers
- Ability to more accurately charge energy bills by customer/business unit
- Data for analysis of faults to understand drifts/triggers
- Identifying hotspots to alleviate stranded power
- 'Node Manager' poles regulator via SMBus (PMBus or other) and aggregates data

## SDK with Web Service APIs for Data Center Power and Thermal Power Management



# Max Efficiency Power Point

- A maximum efficiency may be found for the power system given the load profile of the system.
- Multi-stage systems can adjust operating frequency and output voltages to optimize overall efficiency



- Programmable power enables this capability



# Dynamic Frequency Changes for short run DSL

- Compensated at 600kHz
  - Plotted for
  - 500kHz
  - 429kHz
  - 375kHz
  - 300kHz

## PID Calculator Generic Coefficient Calculator

Inputs

Input Voltage (V)

Output Voltage (V)

Inductor ( $\mu$ H)

Capacitor ( $\mu$ F)

Cap ESR (mOhm)

Max Load Current (I)

Switching Frequency (Hz)

System Clock **28.8MHz / 96**

Zeroes

Bandwidth

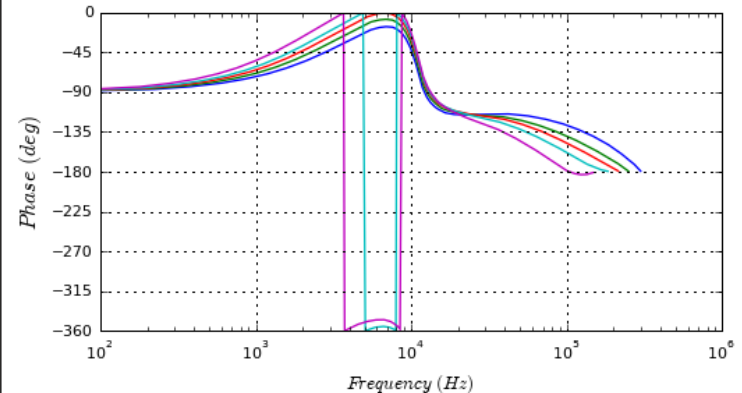
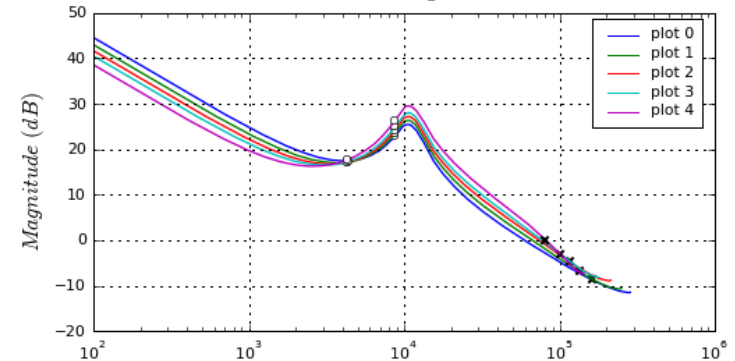
% of sw. freq

Discrete

Outputs

☐ Show Open ☐ Show PID ☒ Show Loop ☒ Show Zeroes ☐ Clear on Calculate

Bode Diagram



System Clock Freq

48 MHz	44.8 MHz	41.6 MHz	38.4 MHz	35.2 MHz	32 MHz	28.8 MHz	25.6 MHz
1.5 MHz	1.4 MHz	1.3 MHz	1.2 MHz	1.1 MHz	1.0 MHz	900 kHz	800 kHz
1.0 MHz	933 kHz	867 kHz	800 kHz	733 kHz	667 kHz	600 kHz	533 kHz
750 kHz	700 kHz	650 kHz	600 kHz	550 kHz	500 kHz	450 kHz	400 kHz
600 kHz	560 kHz	520 kHz	480 kHz	440 kHz	400 kHz	360 kHz	320 kHz
500 kHz	467 kHz	433 kHz	400 kHz	367 kHz	333 kHz	300 kHz	
429 kHz	400 kHz	370 kHz	343 kHz	314 kHz			
375 kHz	350 kHz	325 kHz	300 kHz				

----- plot 4 -----  
A: 0x0478 B: 0x0866 C: 0x03EF D: 0x13 E: 0xC3  
Crossover: 30kHz Phase Margin: 43deg  
Zero 1: 4.29kHz Zero 2: 8.58kHz  
Pole 1: 79.92kHz Input Voltage: 12.0V  
Output Voltage: 1.8V Inductor: 2.2uH  
Capacitor: 100uF Cap ESR: 15m  
Max Load: 3A Zeros: real  
Sw Freq: 300k BW ratio: 10.0  
HP Pole: -3

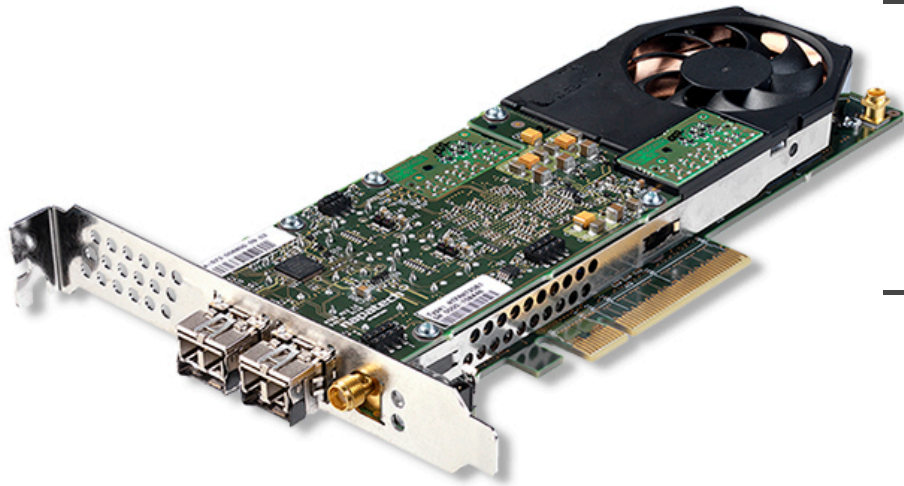
# Power<sup>XR</sup> in Military Applications

- All 4 power stages identical
- uC gets capture signal
- uC then tells XRP7740 to:
  - Output by output, pass input voltage through to output (18V on 40nm processors causes the smoke to come out)
  - Output by output, turn both MOSFETs on at the same time
  - Writes all “1” to entire memory
  - Resets the chip
- Reverse engineering becomes “difficult”

# 2-Port 10G Ethernet Adapter

## FPGA Analogy Incorporated In New Products

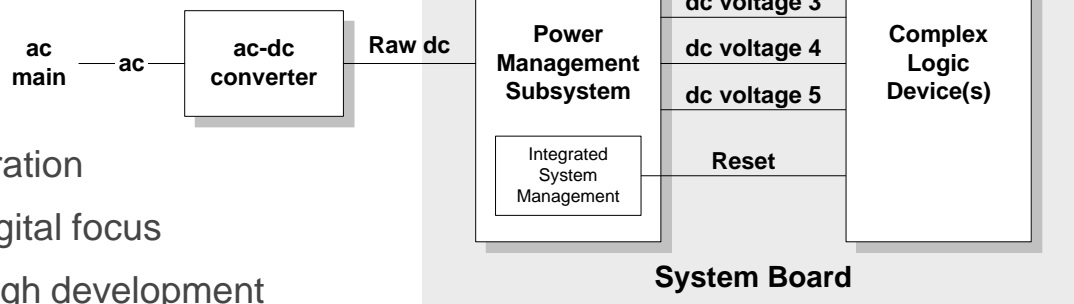
- Dual FPGA based Adapter Features Software Upgradable Features and Performance
- Boards no longer require returns for power system changes to enable new FPGA code
  - Flexibility to change sequencing or voltages of all 8 voltage rails
  - Tailored fault behavior and fault levels



# FPGA Power Supplies

## Challenges & Trends

- **Lower Power**
  - End system performance per watt
  - Standby modes
- **Smaller Size**
  - Lower profile boards
  - Smaller X-Y dimensions
- **Improved intelligence/monitoring**
  - Increased number of power rails
  - More complex sequencing/timing
  - Real time re-configuration
- **Faster TTM**
  - More skews
  - Reduced development time
  - Less time for power design consideration
  - Less power design expertise with digital focus
  - Changing power requirements through development



# FPGA Analogy

## FPGA's appeared

- Slower
- Used more power
- Cost more
- Weren't so hi integration (32 registers!!!)
- Very quickly successful – Why?
  - It was the revolutionary design flow
  - Today that design flow is a culture
  - Hard work done for us – engineers already love it
  - Not available for PSU design – until now!

# Command Sets

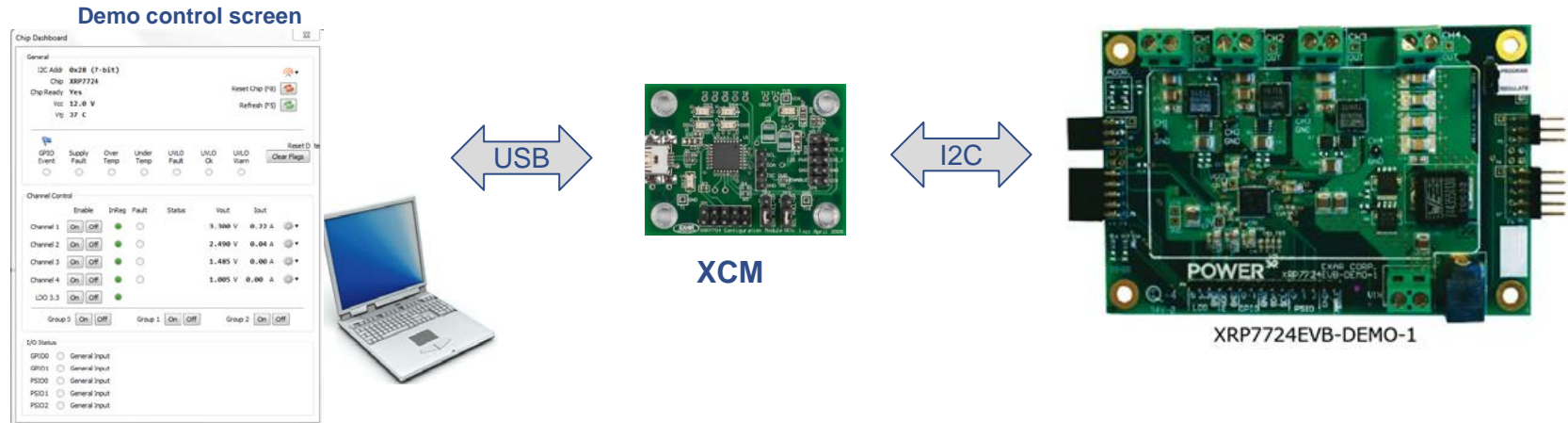
- ANP-31 for XRP7704/08/13/14/40
  - Power<sup>XR</sup> Configuration and Programming
  - Register based programming and configuration
- ANP-38: XRP7724 I<sup>2</sup>C Command Set and Programming Guide
  - Command based instructions
- ANP-39: Loading XRP7724 RAM with Runtime Intel HEX File
  - Register based configuration



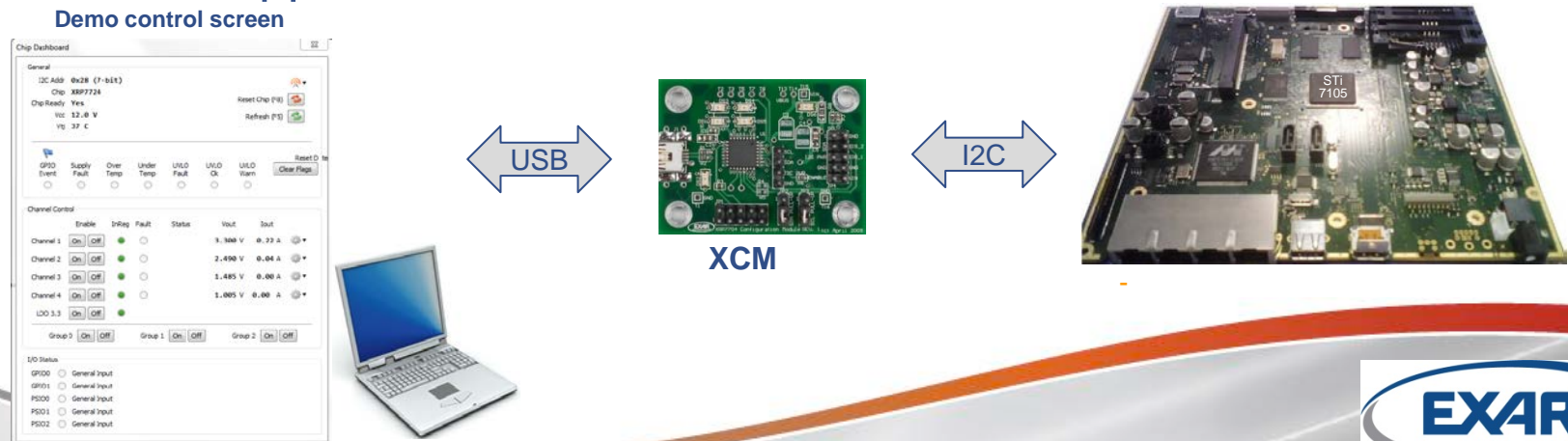
# Programmable Power - Power<sup>XR</sup>

## Easy Development with Power Architect

- From Proof of Concept...



- ...To Actual Application



# The XRP7724 Evaluation Kit

## Complete PowerXR Development Environment

- 1 x XRP7724 Evaluation Board
- 1 x XCM Board
  - XRP7724 Programming
  - USB to I2C Bridge
- Power Architect Software
  - On USB Jump Drive
- USB Cable
- Quick Start Guide





# Technical Support “Hotlines”

Power Management  
Data Reduction & Storage  
Connectivity

[powertechsupport@exar.com](mailto:powertechsupport@exar.com)  
[faehelpdesk@exar.com](mailto:faehelpdesk@exar.com)  
[uarttechsupport@exar.com](mailto:uarttechsupport@exar.com)  
[serialtechsupport@exar.com](mailto:serialtechsupport@exar.com)  
[commtechsupport@exar.com](mailto:commtechsupport@exar.com)

Communications

General

[customersupport@exar.com](mailto:customersupport@exar.com)

## PLUS:

Your local Exar FAE:

Northeast – [ted.madonna@exar.com](mailto:ted.madonna@exar.com)

Southeast & E. Central – [jack.braden@exar.com](mailto:jack.braden@exar.com)

N. & S. Central – [bryan.smith@exar.com](mailto:bryan.smith@exar.com)

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